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New Brazilian species of *Canoparmelia* with medullary olivetoric, anziaic, and sekikaic complexes

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Abstract — *Canoparmelia consanguinea*, *C. roseoreagens,* and *C. subroseoreagens* are described as new. The occurrence of *C. sanguinea* is confirmed for Rio Grande do Sul State, 1000 km south of the type locality. These species all exhibit a C+ rose medullary reaction but differ in their secondary metabolites and vegetative propagules, among other aspects.

Key words — *Parmeliaceae*, *Canoparmelia texana*

Introduction

Canoparmelia, which was proposed by Elix et al. (1986) as a segregate of *Pseudoparmelia* Lynge (Hale 1976), included 28 species characterized by the absence of cilia, a black or brown lower surface, a narrow marginal zone paler than the center, and typically bifusiform or (more rarely) cylindrical or weakly fusiform conidia.

Sixteen years later, Nash & Elix (2002) referred 45 species to this genus, five producing medullary compounds that react C+ rose but none reported for Brazil. However, recently Benatti et al. (2009) described *C. sanguinea*, a C+ species from southeastern Brazil.

Spielmann (2006) reported eight *Canoparmelia* species for Rio Grande do Sul State, species previously recorded by Marcelli (2004) as occurring in Brazil. During a lichen survey in the Municipality of Vacaria, Rio Grande do Sul State, four (three new) species *Canoparmelia* were collected that exhibited a C+ rose medullary reaction.

Material and methods

Morphological features were studied under a stereomicroscope and anatomical sections of the apothecia and pycnidia were made with a razor blade. Spot tests were performed with potassium hydroxide (K), sodium hypochlorite (C) and para-phenylenediamine (P) and the thallus examined under UV light. Lichen substances were detected by thin-layer chromatography (TLC) using solvent C (Huneck & Yoshimura 1996) and high performance liquid chromatography (HPLC) (Elix et al. 2003).

Results and discussion

The three new species described below produce a unique cohort of medullary substances that include olivetoric, anziaic and sekikaic derivatives that are responsible for the C+ rose reaction of the medulla. Apart from *C. sanguinea*, all other *Canoparmelia* species with a C+ rose medulla contain either lecanoric or gyrophoric acid. A key to the described *Canoparmelia* species diagnosed by a C+ rose medulla is presented below ("*" indicates species not cited in the text).

Key for *Canoparmelia* species with C+ rose medulla

1a. Lower surface brown. . . . . *C. amabilis**
1b. Lower surface black 2

2a. Soredia and isidia absent 3
2b. Soredia or isidia present 4

3a. Yellow K+ purple pigment in the medulla . . . . . *C. corrugativa**
3b. Yellow K+ purple pigment absent, medulla uniformly white . . . . . *C. norpruinata**

4a. Soredia present; isidia absent 5
4b. Isidia present; soredia absent 6

5a. Soredia originating directly from the upper surface . . . . . *C. consanguinea*
5b. Soredia originating mostly from the border of "schizidia-like" plaques . . . . . *C. subroseoreagens*

6a. Isidia conspicuously inflated . . . . . *C. rarotongensis*
6b. Isidia cylindrical 7

7a. Isidia initially papillate, then cylindrical to thickened; upper surface rugose towards the center; gyrophoric acid present . . . . . *C. martinicana*
7b. Isidia cylindrical, not thickened; upper surface smooth to cracked; gyrophoric acid absent 8

8a. Isidia simple to slightly ramified; with substances of the anziaic, divaricatic, glomelliferic, and perlatolic acid complex . . . . . *C. sanguinea*
8b. Isidia mostly coralloid, with methyl divarinolcarboxylate and unknown depsides . . . . . *C. roseoreagens*

The new species

Canoparmelia consanguinea Marcelli, Canêz & Elix, **sp. nov.** Fig. 1a

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Diagnosis: *Similis* Canoparmelia sanguinea *substantiis medullae sed soredibus granularibus differt.*

Holotype—Brazil, Rio Grande do Sul State, Municipality of Vacaria, Fazenda da Estrela locality, open field, 28º04'01.8"S, 50º57'45.4"W, 920 m alt., on basaltic rock, col. L.S. Canêz & A.A. Spielmann 892, 13-I-2003 (SP).

Thallus greenish gray (buff in herbarium), lobate to sublaciniate, to 8.5 cm wide. Lobes irregularly branched, (0.8–)1.6–3.0 mm wide, loosely adnate, contiguous, slightly overlapping, apices rounded, margin smooth to crenate, plane to involute, sometimes slightly elevated at the apices; surface continuous to slightly irregularly cracked in the center, smooth, shiny. Lacinulae and Pustulae absent. maculae reticulate, evident on the distal areas. Soralia orbicular, laminal and marginal, blackish when old; soredia granular, persistent, agglutinated, soon forming corticate granules which may develop into irregular pseudoisidia or small lobules in the older parts of the thallus. Medulla white, K+ purple pigment absent. Lower surface black, dull to a little shiny, papillate, smooth in some parts; marginal zone brown, 0.9–2.5 mm wide, smooth to papillate, rarely rugose; rhizines black, some with whitish apices, simple to penicillate, 0.20–1.25 × 0.05–0.10 mm, dense to frequent. apothecia very rare, plane, adnate, submarginal, imperforate, 2.7 mm diam.; margin smooth to sorediate, amphithecium sorediate. Ascospores ellipsoid, 10.0–12.5 × 5.0–6.0 µm, epispore 1.0 µm wide. Pycnidia submarginal, ostiole black, immature; conidia not seen.

Spot tests: cortex K+ yellow, UV–; medulla K– (milky), C+ rose, KC+ rose, P+ pale yellow, UV+ pale blue.

TLC/HPLC: Atranorin (±trace), olivetolcarboxylic acid (major), decarboxynorstenosporic acid (major), 4-*O*-demethylstenosporic acid (major), divaricatinic acid (minor), decarboxyanziaic acid (trace), decarboxystenosporic acid (minor), perlatolic acid (minor), decarboxyperlatolic acid (minor), depsidellin B (minor), depsidellin C (minor), divaricatic acid (minor or trace), subdivaricatic acid (trace), norsubdivaricatic acid (trace).

Comments– *Canoparmelia consanguinea* is characterized by orbicular soralia, a C+ rose medullary reaction, and a complex medullary chemistry. In addition, this species has granular soredia, which often form corticate granules that may develop into irregular pseudoisidia or lobules.

Canoparmelia consanguinea is morphologically similar to *C. sanguinea,* which also reacts C+ red (hence the name) and produces a very similar cohort of lichen acids, namely olivetolcarboxylic acid (minor), 4-*O*-

methylolivetolcarboxylic acid (minor), glomelliferic acid (minor/absent), glomellin (trace/minor), decarboxyanziaic acid (major), decarboxystenosporic acid (minor), decarboxyperlatolic acid (minor), divaricatinic acid (minor), depsidellin B (minor), unknowns (minor) (Benatti et al. 2009). However, *C. sanguinea* has true isidia rather than soredia.

The new species *C. subroseoreagens* (described below) also produces soredia and reacts C+ rose but has a different chemistry, a peculiar upper surface, and a very unique means of producing soredia.

In the field, *C. consanguinea* might be confused with *C. texana* (Tuck.) Elix & Hale, a very abundant lichen in Brazil, since both species have orbicular soralia. However, *C. texana* has a much simpler chemistry, producing only divaricatic acid (C–, KC+ purplish) in the medulla.

Canoparmelia roseoreagens Marcelli, Canêz & Elix, **sp. nov.** Fig. 1b

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Diagnosis: *Similis* Canoparmelia sanguinea *medulla C+ rosa et praesentia isidiorum sed substantiis medullae differt.*

Holotype—Brazil, Rio Grande do Sul State, Municipality of Vacaria, Fazenda da Estrela locality, *Araucaria angustifolia* forest, 28º03'58,8"S, 50º57'34,1"W, 905 m alt., on tree bark, leg. L.S. Canêz & A.A. Spielmann 96, 03-III-2003 (SP, isotype in H).

Thallus grayish, sublaciniate, to 9.0 cm wide. sublaciniae irregularly branched, 0.9–2.5 wide, adnate, contiguous, apices truncate, margin smooth to crenate; upper surface smooth, continuous to slightly cracked in the center of the thallus; maculae weak or absent, reticulate, more evident in the young parts, sometimes forming small cracks. Lacinules, pustules and soredia absent. Isidia concolorous with the thallus, cylindrical, simple to mostly coralloid when mature, 0.10–0.45 × 0.05 mm, erect, firm, laminal, apices eciliate, brown. Medulla white, K+ purple pigment absent. Lower surface black to dark brown, slightly shiny, rugose; marginal zone brown, shiny, 0.5–1.5 mm wide, rugose, rarely papillate; rhizines white, dark brown or rarely black, simple to furcate, 0.25–0.50 × 0.05–0.08 mm, few to frequent, almost evenly distributed. Apothecia and Pycnidia not seen.

Spot tests: cortex K+ yellow, UV–; medulla K–, C+ rose, KC+ rose, P+ pale yellow, UV–.

TLC/HPLC: Atranorin (±minor), methyl olivetolcarboxylate (major), methyl divarinolcarboxylate (major), eight major unknown depsides (derivatives of norsekikaic acid, norhomosekikaic acid and norhyperhomosekikaic acids or their corresponding methyl esters).

Comments– *Canoparmelia roseoreagens* is a maculate, isidiate species with a rugose lower surface and a complex medullary chemistry. This species is

probably the isidiate counterpart of the sorediate *C. subroseoreagens* (see below).

Another isidiate species that also has a C+ rose medulla is *C. sanguinea*, but the latter has a different chemistry, which includes substances of the anziaic, divaricatinic, glomelliferic, and perlatolic acid complexes as well depsidellin B, substances that are absent from *C. roseoreagens*. Additionally, the isidia of *C. roseoreagens* are more densely branched (mostly coralloid) than those found in the specimens of *C. sanguinea* (simple to sparsely branched) from various localities in Brazil (see below).

Two other C+ rose isidiate *Canoparmelia* species contain different medullary substances. *C. rarotongensis* Louwhoff & Elix (2000) from the Cook Islands has inflated isidia and produces lecanoric acid, orsellinic acid, and orcinol, while *C. martinicana* (Nyl.) Elix & Hale (from North America and northern South America), has papillate, then cylindrical to thickened, isidia and produces gyrophoric acid, protocetraric acid, and (rarely) norlobaridone (Hale 1976).

In the field, *C. roseoreagens* could be confused with *C. caroliniana* (Nyl.) Elix & Hale, which is very abundant in Brazil. *Canoparmelia caroliniana,* which may have similar isidia and maculation, has a paler grayish-white upper surface and different chemistry, producing perlatolic acid (major), stenosporic acid (major), glomelliferic acid (minor), anziaic acid (trace), 4-*O*-demethylstenosporic acid (trace), divaricatic acid (trace) in the medulla (C–, KC+ faint purple).

Canoparmelia subroseoreagens Canêz, Marcelli & Elix, **sp. nov.** Fig. 1c

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Diagnosis: *Similis* Canoparmelia roseoreagens *substantiis medullae sed praesentia soredium granularium differt.*

Holotype—Brazil, Rio Grande do Sul State, Municipality of Vacaria, Fazenda da Estrela locality, *Araucaria angustifolia* forest, 28°03'58.8"S, 50°57'34.1"W, 905 m alt., on tree bark, leg. L.S. Canêz & A.A. Spielmann 1374, 03-III-2003 (SP, isotype in H).

Thallus grayish, sublaciniate to laciniate, to 6.0 cm wide; laciniae irregularly branched, smooth, plane, adnate, contiguous, 0.5–2.5 mm wide, apices truncate, margin slightly crenate to sinuous, black, surface continuous only in the younger parts, becoming markedly cracked and even forming "schizidia like" plaques in the center of the thallus. maculae weak, reticulate, present at the apices of the lobes. Lacinulae, pustulae and isidia absent. Soralia orbicular, mainly laminal, less frequently marginal; soredia laminal, mostly subgranular, originating mainly from the margins of cracks; granules ±becoming corticate and/or forming small pseudoisidia. Medulla white, K+ purple pigment absent. Lower surface black, shiny, papillate; marginal zone dark brown, opaque to shiny, 0.7–2.0 mm wide, smooth to papillate; rhizines black, rarely

with whitish apices, simple, 0.20–0.85 × 0.05 mm, frequent to abundant, evenly distributed. Apothecia and pycnidia not seen.

Spot tests: upper cortex K+ yellow, UV–; medulla K–, C+ purplish rose, KC+ strongly rose evanescent, P–, UV–.

TLC/HPLC: Atranorin (±trace) olivetolcarboxylic acid (major), twelve major unknown depsides (derivatives of norsekikaic acid, norhomosekikaic acid and norhyperhomosekikaic acid).

Comments– *Canoparmelia subroseoreagens* is characterized by a strongly cracked upper surface, with most soredia originating from the somewhat elevated crack margins to form rounded hollowed structures that resemble open pustules. This species has additionally a unique chemistry, producing olivetolcarboxylic acid (C+ rose) as main medullary substance together with numerous unknown *meta*-depsides.

It is chemically and morphologically related to *C. roseoreagens* described above, but that species produces isidia rather than soredia. The specific epithet refers to this similarity.

A further sorediate C+ species is *C. consanguinea* described above, but that species differs in chemistry and in producing soredia directly from the upper surface, rather than from the border of plaques.

Species new to Rio Grande do Sul

Canoparmelia sanguinea Marcelli, Benatti & Elix, Mycotaxon 106: 436 (2009)

Canoparmelia sanguinea is characterized by a thallus with a C+ rose medullary reaction associated with simple to sparsely branched isidia. The complex medullary chemistry includes olivetolcarboxylic acid (minor), 4-*O*-methylolivetolcarboxylic acid (minor), ±glomelliferic acid (minor), glomellin (trace/minor), decarboxyanziaic acid (major), decarboxystenosporic acid (minor), decarboxyperlatolic acid (minor), divaricatinic acid (minor), depsidellin B (minor), unknowns (minor) (Benatti et al. 2009).

Specimens examined—**Brazil**. Rio Grande do Sul State: Municipality of Vacaria, Fazenda da Estrela locality, gallery forest, 28º02'41"S, 50º56'52,3"W, 800 m alt., on bark of isolated tree in field near right margin of stream, leg. L.S. Canêz & A.A. Spielmann 793, 795, 798, 12-I-2004 (SP); São Paulo State, Municipality of Mairiporã, Cantareira Range, on a tree trunk felled during village construction, 03-XI-1989, leg. M.P. Marcelli 6029 (**Holotype** SP!).

The specimens from Rio Grande do Sul closely resemble the holotype (SP!) except for having a paler colored thallus, more imbricate lobes with somewhat involute lateral margins and by producing traces of anziaic and stenosporic acids in addition to the acids found in the specimens from São Paulo (including the holotype).

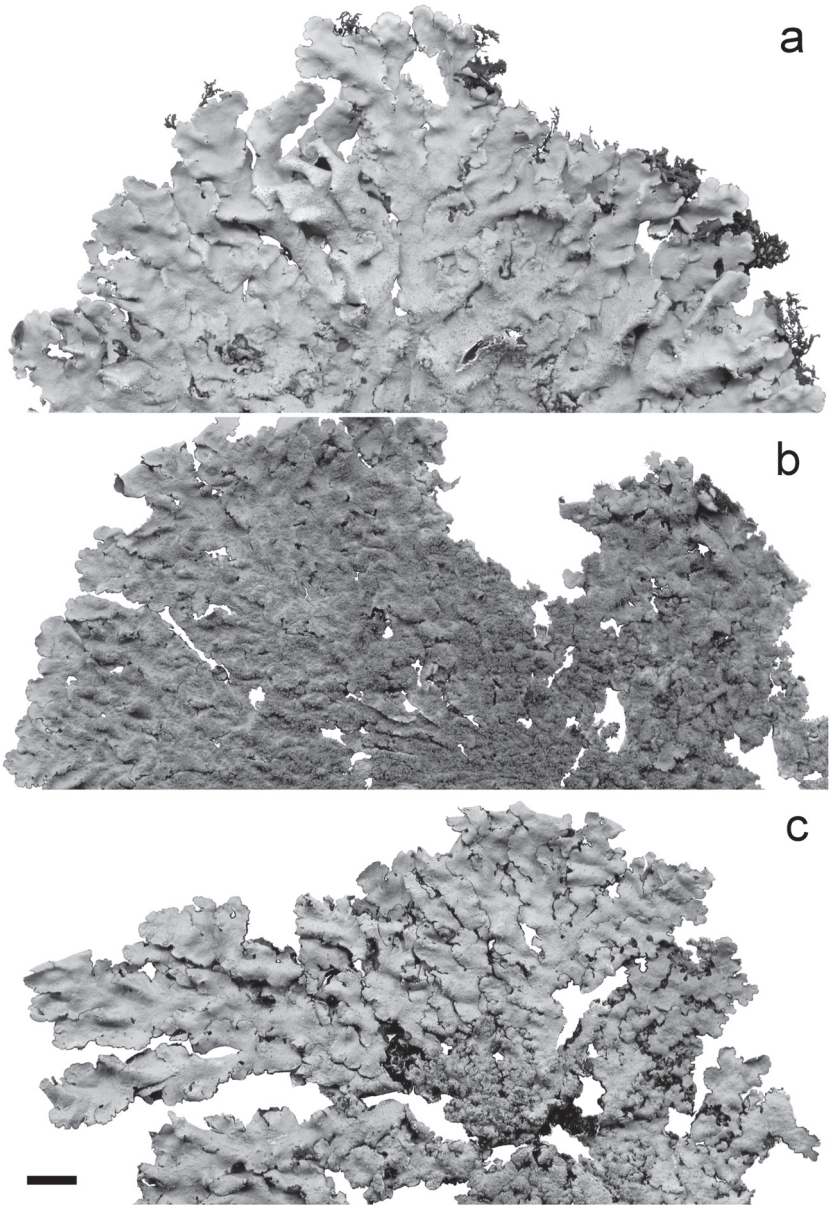

Figure 1a–c. Partial new species holotypes
a. *Canoparmelia consanguinea*; b. *C. roseoreagens*; c. *C. subroseoreagens*

All material was collected in rainforest areas at elevations of 800–900 m, but the Rio Grande do Sul and São Paulo localities are nearly 1000 km apart, considerably extending the known distribution of this species.

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